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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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09/739,929

12/18/2000

Thomas N. Marieb

42390P10637

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07/16/2002

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EXAMINER

HOANG, QUOC DINH

ART UNIT

PAPER NUMBER

2818

DATE MAILED: 07/16/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/739,929

Applicant(s)

MARIEB ET AL.

Examiner

Quoc D Hoang

Art Unit

2818

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 April 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-29 is/are pending in the application.
- 4a) Of the above claim(s) 5,6 and 11 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1-4 and 7-9 is/are allowed.
- 6) ☒ Claim(s) 10-29 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12 March 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

Art Unit: 2818

DETAILED ACTION

Notice to Applicant

1. Applicants' Amendment to the Office Action mailed 04/29/2002 has been entered and made of record as paper number 8.

- Claims 5, 6 and 11 have been cancelled.
- Claims 1-4, 7-10 and 12-29 are pending in the application.

Response to Amendment

2. Applicants' arguments with regard to the rejections under 35 U.S.C. 102 or 103 have been fully considered, but they not deemed to be persuasive for at least the following reasons.

Applicants' argument concerns that cited reference Andricacos do not teach implanting at least one dopant element selected from the group consisting of Al, Mg and Sn into the plated Cu layer. The examiner points out that in col. 5, lines 35-40 and col. 7, lines 2-5, Andricacos clearly disclose ion-implanting a surface of the plated Cu layer with at least Al or Sn.

Applicants' argument concerns that cited reference Havemann does not teach a seed layer comprises Cu and at least one dopant element. Clearly, Havemann., Fig 2c and col. 5, lines 38-40, the layer 29 is a doped layer.

Further applicants argue that Havemann et al., do not teach forming a capping layer over the doped layer, and the layer 31 in Havemann is not a capping layer as claimed by Applicant. Havemann., clearly in lines 5, col. 42-43 and Fig. 2c discloses the second copper layer 31 is formed on the doped copper layer 29. The second copper layer 31 in Havemann et al., and the

Art Unit: 2818

Applicants' capping layer 606 is formed by using the same material of copper, therefore the second copper layer 31 in Havemann et al could be used as a capping layer (see Applicants' specification page 12, lines 20-21).

The previous rejection of claims 10 and 12-29 remains and is repeated below

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371© of this title before the invention thereof by the applicant for patent.

4. Claims 10 and 12-16 are rejected under 35 U.S.C 102(e) as anticipated over Andricacos et al., (US Patent 6,268,291).

Regarding claim 10, Andricacos et al., Figure. 5A-B, and related text on col. 10 which disclose a method of forming a copper interconnect comprising the step of plating a copper layer 100 over a substrate (col. 10, lines 22-32 and Fig. 5B); and implanting at least one dopant element selected from the group consisting Al, Mg, and Sn into the copper layer 100 (col. 10, lines 22-32 and Fig. 5B).

Regarding claim 12, Andricacos et al., teach polishing the copper layer 100 so as to form individual interconnect lines prior to implanting (see Fig. 5B).

Art Unit: 2818

Regarding claims 13-14, Andricacos et al., teach depositing a barrier layer 94 over the interconnect lines subsequent to implanting (col. 10, lines 22-40 and Fig. 5B).

Regarding claim 15, Andricacos et al., teach depositing a barrier layer 94 over the interconnect lines prior to implanting (col. 10, lines 22-40 and Fig. 5B)..

Regarding claim 16, Andricacos et al., teach the dopant is implanted into the surface of the copper layer 100 to depth of about 10 monolayers (col. 12, lines 60-65).

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 17-18 are rejected under 35 U.S.C 103(a) as being unpatentable over Andricacos et al., (US Patent 6,268,291).

Regarding claims 17-18, Andricacos et al., teach the dopant is implanted a dose of 3×10^{15} atoms/cm² at an energy of 50-180 keV, but do not teach the dopant is implanted a dose of 3×10^{15} atoms/cm² at an energy of 5 keV (see Table 4). The energy claimed is considered an obvious design optimization and do not lend novelty to the claimed process. Also, Andricacos do not teach the dopant is implanted to achieve an implant profile peak at 50 angstroms below the Cu surface and a concentration of 1.5 wt% over 100 angstroms.. The concentration claimed is

Art Unit: 2818

considered an obvious design optimization It would have been obvious to implant the dopant to the specified concentration to obtain a desired result.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371© of this title before the invention thereof by the applicant for patent.

8. Claim 19 is rejected under 35 U.S.C 102(e) as anticipated over Havemann et al., (US Patent 6,130,156).

Regarding claim 19, Havemann et al., Figure. 2c, and related text on col. 5 which disclose a method of forming a copper interconnect comprising the step of depositing a seed layer 29 on a substrate, the seed layer 29 comprising Cu and at least one doping element (col. 5, lines 37-42 and Fig. 2c); forming a capping layer 31 over the seed layer 29 (col. 5, lines 42-43 and Fig. 2c); forming a copper layer 33 over the capping layer 31 (col. 5, lines 44-45 and Fig. 2c); and driving the at least one doping element from the seed layer 29 into the copper layer 33 (col. 5, lines 45-60 and Fig. 2c).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are

Art Unit: 2818

such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 20-29 are rejected under 35 U.S.C 103(a) as being unpatentable over Havemann et al., (US Patent 6,130,156) in view of Chiang et al., (US Patent 6,160,315).

Regarding claims 20-21, Havemann et al., teach the seed layer 29 and the capping layer 31 are formed sequentially, but do not clearly teach not exposing the seed layer to the atmosphere prior to deposition of the capping layer 31 (col. 5, lines 25-60 and Fig. 2c). However, it would be easy to realize that the capping layer is deposited on the seed layer in order to prevent oxidation of the seed layer.

Regarding claims 22-23, Havemann et al., teach depositing the seed layer 29 comprises sputtering a metal alloy of CuSn (col. 5, lines 38-42).

Regarding claim 24, Havemann et al., teach the capping layer 31 comprises sputtering Cu (col. 5, lines 42-44).

Regarding claim 25, Havemann et al., teach driving the at least one doping element from the seed layer 29 into the Cu layer using the thermal annealing without teaching the precise temperature ranges as claimed. The temperature claimed is considered an obvious design optimization and do not lend novelty to the claimed process.

Regarding claims 25-29, Chiang et al., Figure. 9, and related text on col. 7-8 which disclose a method of forming a copper alloy interconnect comprising the step of exposing at least

Art Unit: 2818

the surface of the copper layer 72 to an ambient that reacts with the doping element (col. 7, lines 40-67 and col. 8, lines 1-62 and Fig. 9).

Havemann et al. and Chiang et al. are combinable because they are from the same field of endeavor. At the time of the invention it would have been obvious to a person of ordinary skill in the art to expose the surface of the copper layer to an ambient that reacts with the doping element in order to minimize surface corrosion of the copper layer. Therefore, it would have been obvious to combine Havemann et al. with Chiang et al.

Allowable Subject Matter

11. Claims 1-4 and 7-9 are allowed.

Conclusion


12. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Art Unit: 2818

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Quoc Hoang whose telephone number is (703)306-5795. The examiner can normally be reached on M-F 8:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Nelms can be reached on (703) 308-4910. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.


Quoc Hoang
Patent Examiner/AU 2818


David Nelms
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